

CLAIMS

1. A method for bonding a first element of an electrochemical cell stack to a second element of the cell stack, the method comprising:

providing at least one complex groove in a first sealing surface of the first element of the electrochemical cell stack, the complex groove having at least one raised portion and at least one depressed portion, the at least one raised portion being located above the depressed portion, the at least one raised portion being configured to receive and retain a bead of adhesive;

depositing the bead of adhesive on the at least one raised portion of the at least one complex groove;

abutting a second sealing surface of the second element of the electrochemical cell stack against the first sealing surface of the first element of the electrochemical cell stack such that the second sealing surface displaces at least a portion of the bead of adhesive from the at least one raised portion of the complex groove; and

receiving the portion of the bead of adhesive in the at least one depressed portion of the groove.

2. The method of claim 1 wherein the first and second elements are cell separator plates.

3. The method of claim 2 wherein the sealing surfaces of the separator plates cooperate to form coolant channels.

4. The method of claim 1 wherein the first element is a cell separator plate and the second element is an electrode.

5. The method of claim 1 wherein providing at least one complex groove comprises providing a complex groove having one raised portion and two depressed portions, the raised portion being positioned between the depressed portions.

6. The method of claim 1 wherein providing at least one complex groove comprises providing a complex groove having one raised portion and two depressed portions, the raised portion having a convex cross-section and being positioned between the depressed portions.

7. The method of claim 1 wherein depositing the bead of adhesive comprises screen printing the bead of adhesive onto the raised portion of the complex groove.

8. The method of claim 1 wherein depositing the bead of adhesive comprises screen printing the bead of adhesive onto the second sealing surface of the second element, and abutting the second sealing surface of the second element against the first sealing surface of the first element.

9. An electrochemical cell comprising:

a membrane electrode assembly having an ion exchange membrane interposed between first and second electrode layers;

a first body positioned on the first side of the membrane electrode assembly, the first body being configured to direct at least one of a fuel and an oxidant to at least a portion of the first electrode layer; and

a second body positioned on the second side of the membrane electrode assembly, the second body being configured to direct the other of the fuel and the oxidant to at least a portion of the second electrode layer, a sealing surface of the second body having at least one sealing groove with a complex cross-sectional shape, a shallow portion of the cross-sectional shape being sufficiently wide to receive and retain a volume of adhesive prior to assembly of the electrochemical cell, and a deep portion of the cross-sectional shape being configured to receive a portion of the volume of adhesive that is displaced from the shallow portion during assembly of the electrochemical cell, the deep portion being immediately adjacent the shallow portion.

10. The electrochemical cell of claim 9 wherein the at least one sealing groove is positioned on a surface of the second body facing away from the membrane electrode assembly.

11. The electrochemical cell of claim 9 wherein the at least one sealing groove comprises a plurality of sealing grooves.

12. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a flat portion.

13. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a surface that is rougher than the surrounding surfaces.

14. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a flat portion oriented to be substantially aligned with a plane of the membrane electrode assembly.

15. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a curved portion.

16. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a convex curved portion.

17. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove comprises a concave curved portion.

18. The electrochemical cell of claim 9 wherein the deep portion is a first deep portion, and further comprising a second deep portion.

19. The electrochemical cell of claim 9 wherein the deep portion is a first deep portion, and further comprising a second deep portion positioned on a side of the shallow portion opposite the first deep portion, the second deep portion being configured to receive a portion of the volume of adhesive that is displaced from the shallow portion of the at least one sealing groove during assembly of the electrochemical cell.

20. The electrochemical cell of claim 9 wherein the at least one sealing groove has a width measuring approximately 1.0-2.0 mm.

21. The electrochemical cell of claim 9 wherein the at least one sealing groove has a width measuring approximately 1.5 mm.

22. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove has a width measuring approximately 0.3-1.3 mm.

23. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove has a width measuring approximately 1.0 mm.

24. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove has a depth below the sealing surface measuring approximately 25-130  $\mu\text{m}$ .

25. The electrochemical cell of claim 9 wherein the shallow portion of the at least one sealing groove has a depth below the sealing surface measuring approximately 50  $\mu\text{m}$ .

26. The electrochemical cell of claim 9 wherein the deep portion of the at least one sealing groove has a depth below the sealing surface measuring approximately 130-630  $\mu\text{m}$ .

27. The electrochemical cell of claim 9 wherein the deep portion of the at least one sealing groove has a depth below the sealing surface measuring approximately 200  $\mu\text{m}$ .

28. An electrochemical cell for use in combination with other electrochemical cells to form a cell stack, the electrochemical cell comprising:

a membrane electrode assembly having a membrane interposed between first and second electrode layers;

a first body positioned on the first side of the membrane electrode assembly, an inner surface of the first body abutting the membrane electrode assembly and being configured to direct at least one of a fuel and an oxidant to at least a portion of the first electrode; and

a second body positioned on the second side of the membrane electrode assembly, an inner surface of the second body abutting the membrane electrode assembly and being configured to direct the other of the fuel and the oxidant to at least a portion of the second electrode, an outer surface of the second body having at least one sealing groove with a complex cross-sectional shape, a first portion of the at least one sealing groove being sufficiently wide to receive and retain a volume of adhesive prior to assembly of the cell stack, and a second portion of the at least one sealing groove being configured to receive a portion of the volume of adhesive that is displaced from the first portion of the at least one sealing groove during assembly of the cell stack, at least a portion of the second portion of the at least one sealing groove being spaced further from a plane of the outer surface of the second body than the first portion of the at least one sealing groove.

29. The electrochemical cell of claim 28 wherein an outer surface of the first body comprises a sealing portion positioned to align with the at least one sealing groove on a body of an adjacent electrochemical cell in the cell stack, the sealing portion being adapted to facilitate engagement with the adhesive.

30. The electrochemical cell of claim 28 wherein an outer surface of the first body comprises a sealing portion positioned to align with the at least one sealing groove on a

body of an adjacent electrochemical cell in the cell stack, the sealing portion being substantially flat.

31. The electrochemical cell of claim 28 wherein an outer surface of the first body comprises a sealing portion positioned to align with the at least one sealing groove on a body of an adjacent electrochemical cell in the cell stack, the sealing portion being rougher than the surrounding surfaces.

32. The electrochemical cell of claim 28 wherein the first body further comprises a plurality of coolant channels.

33. The electrochemical cell of claim 28 wherein an outer surface of the first body further comprises a plurality of coolant grooves configured to abut the outer surface of a body of an adjacent electrochemical cell in the cell stack to form coolant channels therebetween, the at least one sealing groove being positioned to encircle the coolant grooves to retain a coolant fluid within the coolant channels during operation.

34. A plate for use in an electrochemical cell, comprising:  
a sealing groove with a complex cross-sectional shape, a first portion of the sealing groove being sized and shaped to receive and retain a volume of adhesive prior to assembly of the electrochemical cell, and a second portion of the sealing groove being configured to receive a portion of the volume of adhesive that is displaced from the first portion of the sealing groove during assembly of the electrochemical cell.

35. The plate of claim 34 wherein the second portion of the sealing groove is deeper than the first portion of the sealing groove.

36. The plate of claim 34, further comprising a third portion of the sealing groove, the third portion being located opposite the first portion from the second portion, the

third portion being configured to receive a portion of the volume of adhesive that is displaced from the first portion of the sealing groove during assembly of the electrochemical cell.